

Grid-Tied Solar Photovoltaic Systems (Course Outline)

The training provided in this course covers the introduction to photovoltaics, electrical theory, & grid-tied photovoltaic systems core competencies as developed by NABCEP and outlined in the PV Installer Task Analysis.

Provided Items

The following items will be provided by BrawnHumus Inc.

- [Photovoltaic Systems \(second edition\)](#)
- Course Binder & Handouts

Required Items

Students are required to provide the following items.

- [2011 National Electrical Code](#) or the [2011 National Electrical Code Handbook](#)
- Scientific Calculator
- Pen or Pencil
- Notebook

Course Material & Training Methods

The primary course material will come from the Photovoltaic Systems (second edition) textbook and Articles 690 of the 2011 NEC. A variety of training methods will be used including textbook readings, classroom instruction, PowerPoint presentations, hands-on lab demonstrations, and design worksheets.

NEC Course Objectives

Upon completion of this course, students will be able to complete the following National Electrical Code objectives:

- **Article 100**
 - Understand the differences between GFCI & GFP.
 - Differentiate between grounded, grounding, & ungrounded conductors.
- **Article 110**
 - Provide sufficient space around all electrical equipment.
- **Article 200**
 - Ensure proper conductor marking.
- **Article 210 & 215**
 - Calculate voltage drop in 1-phase & 3-phase PV systems.

- **Article 240**
 - Determine overcurrent protection sizes.
- **Article 250**
 - Identify ac & dc system grounding requirements.
- **Article 310**
 - Calculate conductor sizing, derating, & conduit fill.
- **Article 690**
 - Identify PV system types & associated components.
 - Calculate minimum & maximum circuit voltages.
 - Calculate circuit sizing & current.
 - Identify ac & dc disconnect and overcurrent device locations.
 - Determine insulation requirements depending on conductor location.
 - Design ac & dc system grounding installations.
 - Use proper system & equipment marking.
- **Article 705**
 - Determine whether to make a utility line or load-side connection.
 - Provide utility-interactive inverter connections.

PV Design Course Objectives

Upon completion of this course, students will be able to complete the following photovoltaic design objectives:

- Identify renewable & non-renewable energy sources.
- Analyze utility bills & determine rate structures.
- Recognize opportunities for energy efficiency measures.
- Differentiate between alternating current & direct current.
- Recognize differences between series, parallel, & combination circuits.
- Calculate voltage, amperage, & resistance in electrical circuits.
- Calculate power & energy production in PV systems.
- Determine the proper orientation & tilt for a given site.
- Understand the negative effects of shading.
- Calculate module spacing to eliminate inter-row shading.
- Perform a site analysis & determine the solar resources available.
- Recognize the different components of a PV system.
- Evaluate the pros & cons of different PV mounting types.
- Understand the effects of extreme temperature & sunlight on PV cells.
- Diagram PV modules in series, parallel, & combination.
- Identify module efficiencies, degradation, & warranties.
- Identify inverter efficiencies & warranties.
- Recognize the benefits of inverters using maximum power point tracking.
- Analyze different inverter wave outputs.
- Calculate fastener sizes based on loading & structure types.
- Diagram a 1-line & 3-line grid-tied PV system configuration.
- Recognize blueprint electrical symbols.
- Evaluate system troubleshooting & maintenance issues.
- Size a simple grid-tied PV system.
- Calculate the total efficiency & output of a PV system.
- Estimate the total installed cost of a PV system & navigate the system permitting processes, rebates, & payback.
- Safely work on grid-tied PV systems by following OSHA requirements.